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Identification of Plant Leaf Diseases using Machine Learning Algorithms

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Abstract:

A country's innovation growth depends on its agriculture or agribusiness. Agriculture, mother of all the cultures, which provides food and raw materials.It is essential to living beings as a source of nutrition. Plant diseases are therefore becoming a major problem for humans. Plant diseases can happen at any time, It may be happen between harvesting and sowing. It is a great loss of economic value in the market. Therefore, the detection of leaf diseases plays an important role in agriculture. Therefore, disease detection has been carried out using traditional methods. However, the traditional method of detecting leaf diseases is empty-eye observation by agricultural experts or plant pathologists.Detecting diseases of the leaves of plants using this method, which can be subjective, time consuming, and profitable, requires a large amount of manpower and an extensive knowledge of plant diseases. With the help of an experimental evaluation software solution, plant leaf diseases can be automatically recognized and classified. Machine learning is being used for a new development. Machine learning is used to detect diseases in plants. Machine learning is one of the subsections of artificial intelligence to work automatically or to give instructions for a specific task. The main goal of machine learning is to grasp the training data and incorporate it into models that will be useful to humans. As a result, we can use machine learning to detect plant diseases. It helped make good decisions and predict the large amount of data. The color of the leaves, the extent of damage to the leaves, the leaf area of the unhealthy plant is used in the classification. In this regard, various machine learning algorithms are reviewed to identify various diseases of the leaves of plants and identify the best precision.

Keywords: Classification, Disease Detection, Machine Learning Algorithms, Feature extraction, CNN, Deep learning, Inception v3

1.Introduction

India is a developing country, and agriculture is one of the most important aspects of our country's development. Agriculture played a significant role in the advancement of human modern civilisation.Agriculture has become one of the fundamental building blocks of every civilization. For several years, India has been one of the most important agricultural countries.Agriculture has a long and prosperous tradition, and it is an integral segment of the business. Growing vegetables like potatoes, tomato etc is more effective in India's diverse range of subtropical climates. The aim is to expand plane land for crop cultivation, improve food production, and sustainable alternatives systems. Employment prospects are also provided. Agriculture is the primary source of earnings and provides raw materials to the food sector.

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A diseased plant is something that has been obstructed in contexts of the natural state it should have governed.A disease is often said to interact with production and reduce the essentialness of a plant. Diseases in India tend to change with the seasons, depending on the environmental conditions. These diseases are controlled by pathogenic organisms and the variation of agricultural crop during the season. Plant diseases can include fungal, bacterial, and viral infections. Blight, rot, mould, spot, wilt, mildew, and cankers are examples of diseases. Bacterial diseases come in various forms, such as spot, bacterial blight, wilt, and rot. Mottle, for example, is a viral disease.They can be harmful to both the environment and farming land. Late Blight or Early Blight can be detected on leaf tissue, but manually spotting is time - consuming process. As a result, modern proposals are needed.

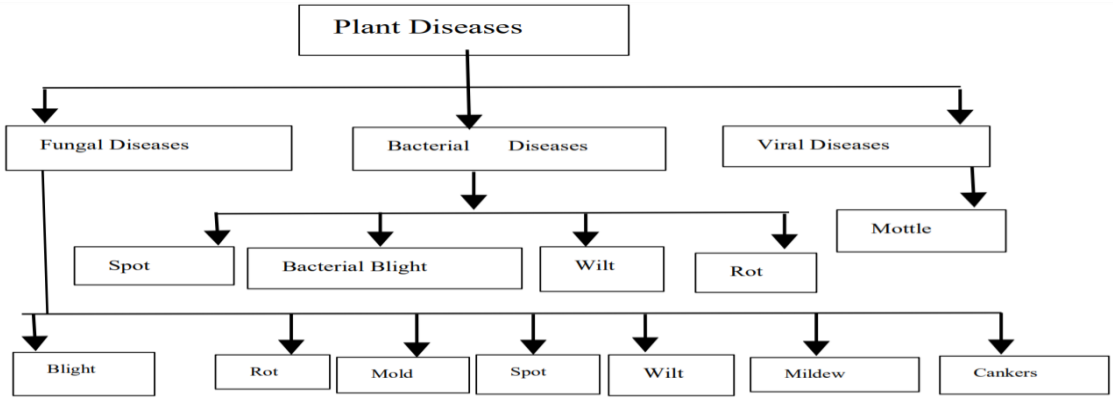

Figure 1. Fungal diseases in plants

Image processing and computer vision can be used to detect objects and their unique features in images in a variety of ways. In Deep learning CNN model is one of most successful methods. In our scenario, the model can predictive based on a leaf image. In this project we examine the leaf diseases of rice plant.

2. Literature Survey:

2.1.Sherly et al. (2019) implemented that several diseases caused by various types of bacteria or fungus in plants are being identified by the deep learning prediction system.The classification algorithm is difficult to use to classify diseases that does not provide accurate results, which would be primarily given the different data input to the algorithm.Various algorithms are tested by various researchers. And different operations produce different outputs.As a result, we can conclude that plants can be affected by various viral infection issues, bacteria and fungi signs infection. The classification technique categorizes and automates physical characteristics. We can use the CNN technique to identify diseases in different plants like rice, apple, and mulberry.

2.2. Shima et al. (2018) proposed that food security can be reduced as a result of plant disease caused by pests and microorganisms, which is also the root source of food vulnerability. Many studies have used machine learning to identify disease in plant leaves. Machine learning methods include RF processes, NN processes, SVM processes, K-means processes, and CNN processes. The random forest algorithm is used for classification. The disadvantages of machine learning algorithms such as decision trees and random forest can be overcome by data overfitting because it includes all kinds of data and numerical values.To calculate the histogram, the picture should first be transformed to HSV, that can be done by

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converting RGB images to HSV pictures. The author's objective is to discover the disease using a naïve bayes classifier.

3. Proposed Methodology:

Convolutional neural networks are image processing techniques used in this project to detect plant leaf diseases in rice plants. In this project, CNN is developed using VGG19, Inception V3 and Inception resnetV2to grasp and recognise the leaf disease. They are made reference to adjust vector. This is due to their weight-sharing architectural design and transcription invariance properties. As a result, they're also known as space invariant neural network algorithms.They are used in optimization techniques, image or video recognition, medical diagnosis, object recognition, speech recognition orNLP(natural language processing), cognitive interfaces, and economic series data. They also govern a wide range of additional applications in different areas.

Process Flow Diagram:

In the following stage, the input data image is obtained and pre - processed until being conversion into module form for comparative analysis.The chosen dataset is efficiently separated and formatted before being renamed and placed in the appropriate folders. The model trained using CNN(using VGG19, Inception V3, and Inception resnetV2 architectures) and then the CNN based classification takes place then it compares whether the leaf is in healthy state or unhealthy state and display the result with remedies and treatment of the related plant leaf disease.

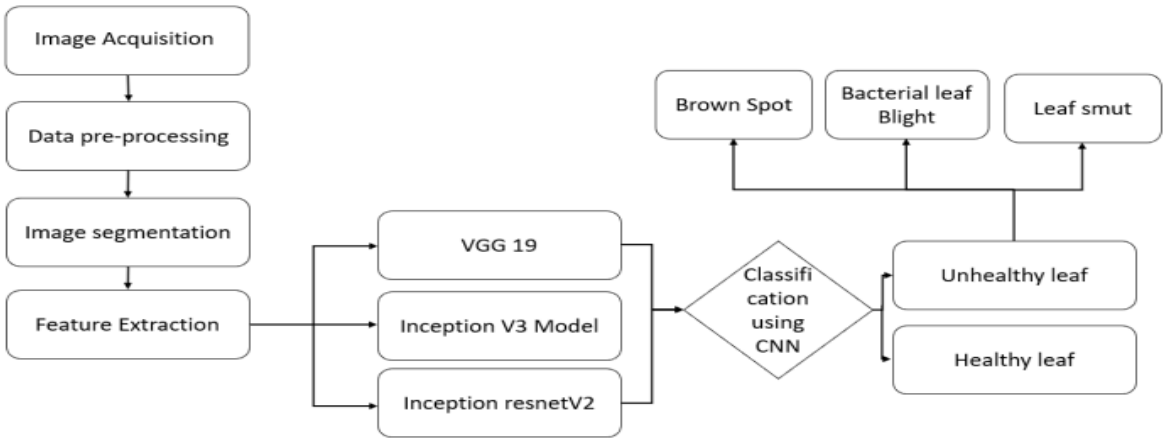

Figure 2: Flow diagram

4. Experimentation and results:

4.1. Dataset

An effective and perfect dataset is allowed for this paper's plant leaf disease recognition processes. The proposed system's beginning step is to train the framework. Analyse the performance of the system after including data.Essentially, normal and abnormal leaves are required as dataset. Image acquisition is a process which is defined as image processing as the action of obtaining an image from dataset, typically a handset source, for storage. It

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would be the first step in the workflow sequence as no other processing is possible without an image. The image identification is completely unprocessed.

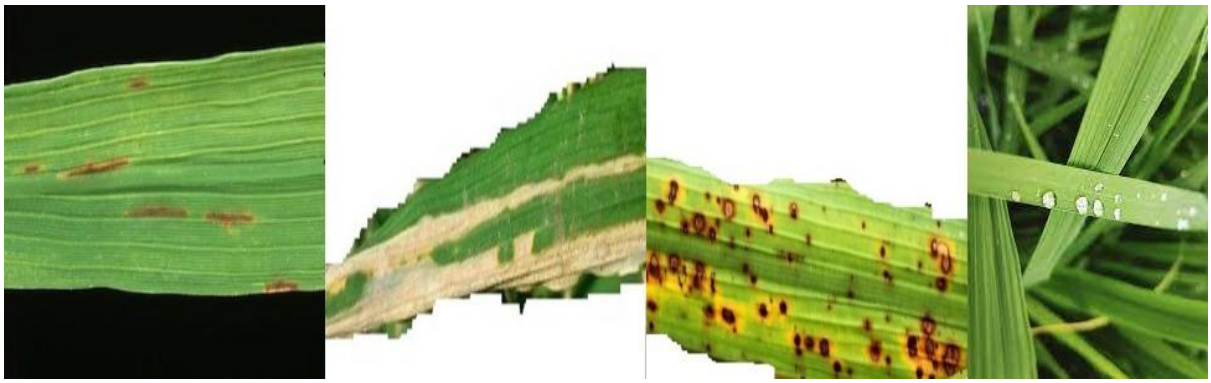

Figure: 3. Healthy and Unhealthy Rice leaves

4.2. Image Pre-processing

Data pre-processing refers to all modifications performed on original data prior to feeding everything to a neural networks or deep learning algorithms. For example, learning a convolutional neural network on image files will almost certainly result in poor classification results. Pre-processing is also essential for accelerating training. Pre-processing is the second and important step which we use in plant leaf disease detection in this step we apply pre-processing techniques like standardization, normalization, and whitening or sphering (i.e., want to convert into co-variance matrix).

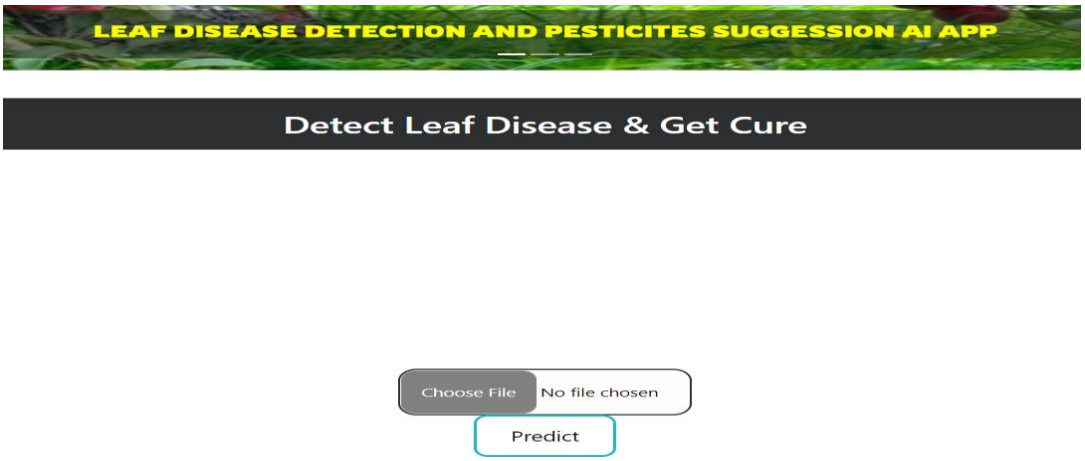

Figure 4: Web page of uploading data input

4.3. Image Segmentation

In deep learning or machine learning the image segmentation is a process of dividing a digital image into several parts or segments (i.e., set of pixels is known as image objects). The main aim of image segmentation is to modify the presentation of an image into meaningful and easy to analyse. The image segmentation plays a vital role in this project as it divides the input image into certain parts and then we can easily detect plant leaf diseases of the given input dataset.

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4.4. Feature Extraction

Proposed approach: In this project, we used a CNN (convolutional neural networks) based model that trains on a pre-processed data source which we given as an input using supervised learning technique (i.e., CNN). For the process of extraction of characteristics, Inception V3, VGG19, Inception resnetV2 are used.

4.4.1. VGG19 (Visual Geometric Group 19):The pretrained model was developed by the Visual Geometric Group (VGG) at the University of Oxford, hence the name VGG.VGG Net's basic operating concept has been to use deeper levels with smaller filters. When constructing a new model, a convolutional layer with VGG-blocks is a great place to start because it is simple and easy to grasp, easy to execute, and very efficient at extracting the features.The VGG19 architectural design input data dimension is set to 244* 244.The architectures of VGG-16 and VGG-19 are the same, but the number of layers varies. VGG-16 utilizes 16 layers, while VGG-19 utilizes 19 layers. The number of convolution layers in the third, fourth, and fifth layers of convolutional layer stacks is the defining difference.

In the two stages, the input data image is captured and filtered before being converted into module form of comparative analysis.The identified dataset is efficiently separated and pre - processed before being reclassified into appropriate documents. The model has been trained perfectly utilising convolutional neural networks (VGG19 architecture), and then characterization occurs.

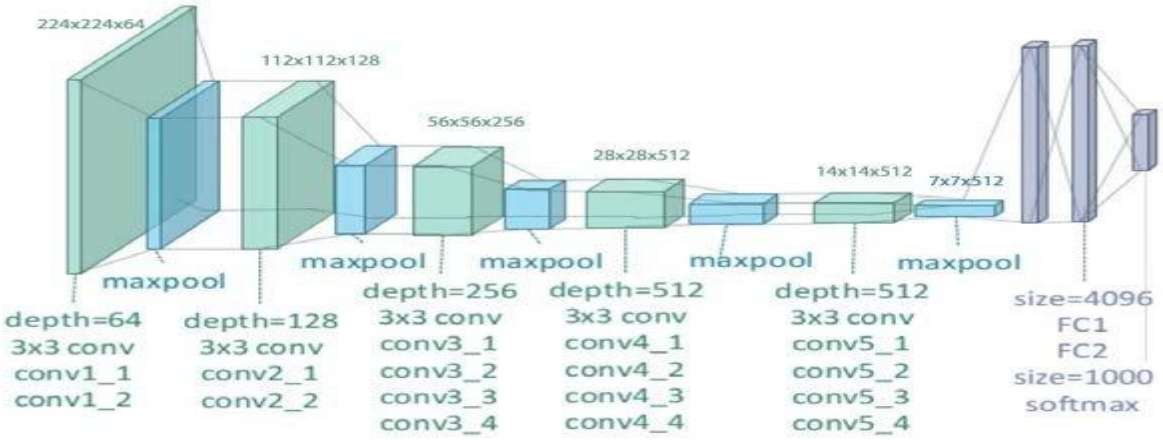

Figure 5: VGG19

Data pre-processing is the method of subtracting the mean RGB value for each and every pixel in the input data. Following pre - processing stage has a stack of 5 convolutional layers, which are each followed by a Max Pooling layer, i.e., each collection of convolution operation is followed by a Max Pooling layer.Visual Geometric Group network comes in a variety of types, the most notable of which are VGG-16 and VGG19. The architectures of VGG-16 and VGG-19 are the same, but the number of layers differs. VGG-16 utilizes 16 layers, while VGG-19 utilizes 19 layers. The number of convolutional layers in the third, fourth, and fifth layers of convolutional stacks is the distinguishing factor.

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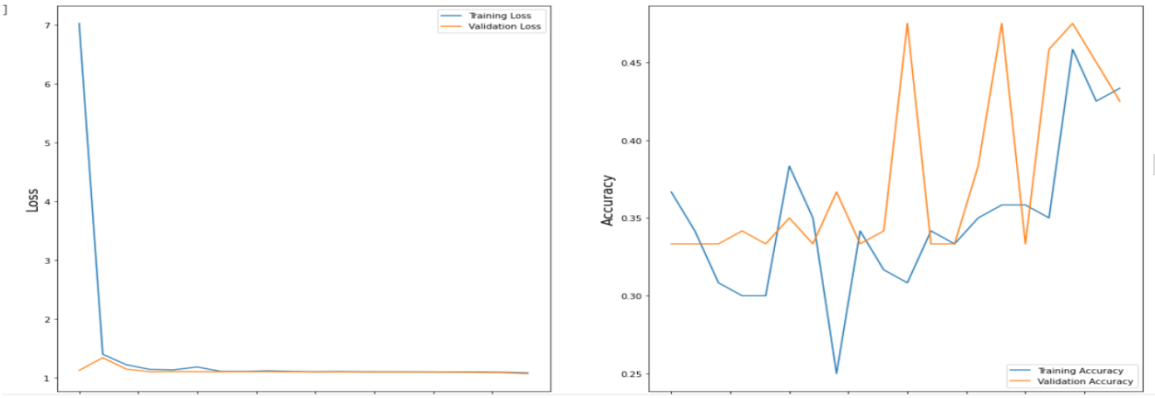

Figure 6: Outputs of VGG19 feature extraction graph

4.4.2. Inception V3 model:

In this project, The Inception v3 architecture is used for extracting features. Google and a group of other researchers collaborated to create Inception. Convolutions, max pooling layers, dropouts, completely linked layers, and batch normalization are now the foundations of Inception v3. Batch norm is being used in the model and therefore is extended to inputs. Image segmentation allows the model to clearly differentiate between all the picture's features and recognize them for any further analysis.

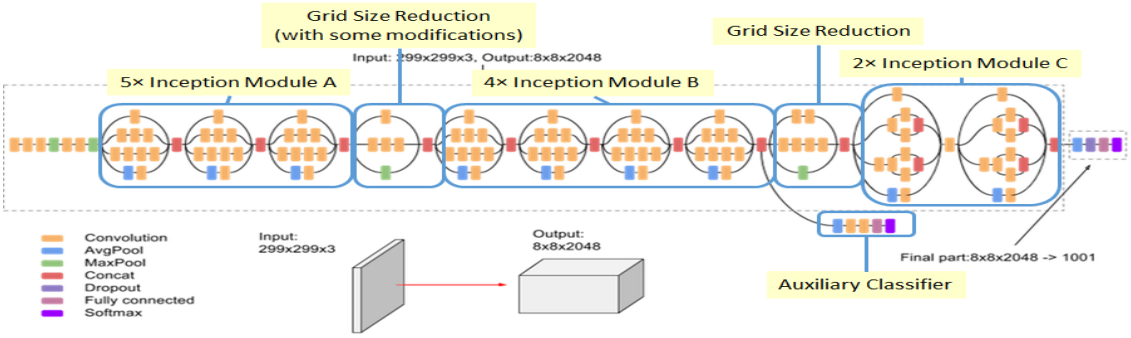

Figure 7: Inception V3

We used histogram equalisation as a training stage to improve the comparison. Furthermore, the image data are rearranged to meet the required standards of the particular network (for example, for VGG (Visual geometric group), the image is transformed to 244 * 244). For calculating accuracy vs epochs, we need us below formula.

$$L = -\frac{1}{N}\sum_{i}^{N}\sum_{j}^{M} y_{ij} \cdot Ln\,(p_{ij})$$

N represents number of classes in the dataset.

M represents number of labels.

Y_{ij} depicts if the i^{th} object in the dataset belongs to the j^{th} label (i.e., Boolean value).

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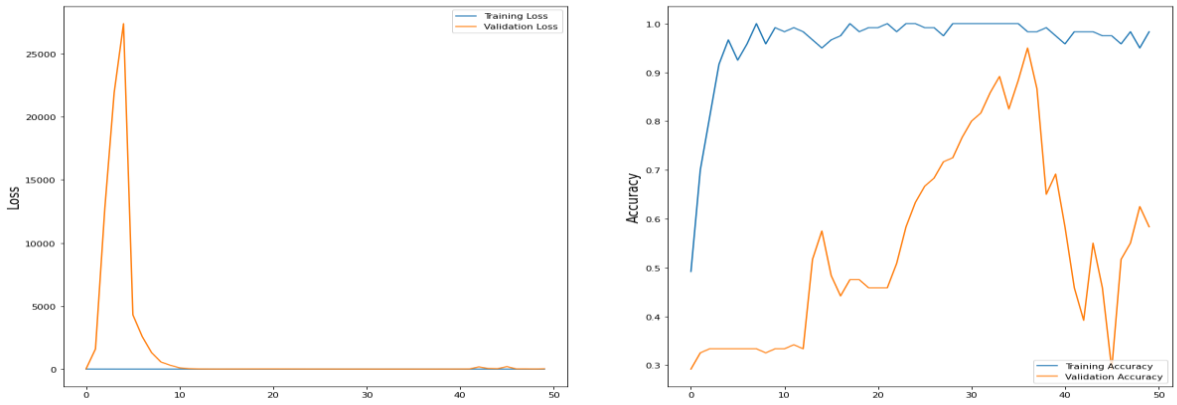

Figure 8: Outputs of Inception V3 model feature extraction graph

4.4.3. Inception resnetV2:

Kaiming He et al. presented the Residual Network (ResNetV2), design for deep neural networks or Convolution neural network in their 2016 paper titled "Deep Residual Learning for Image Recognition," that succeeded on the 2015 version of the ILSVRC task. The residual module was a crucial ResNetV2 innovation. The identity residual model is a layer of convolution layer with same number of inputs and a smaller step size, in which the performance of the new stage is applied to both the input of the very first convolution layers. "***When the dimensions [...] grow larger, we consider two options: (A) The shortcut continues to conduct identity mapping, with extra zero entries padded to increase dimension. This option adds no new parameters; (B) The projection shortcut [...] is used to fit dimensions (11 convolutions are used).***"

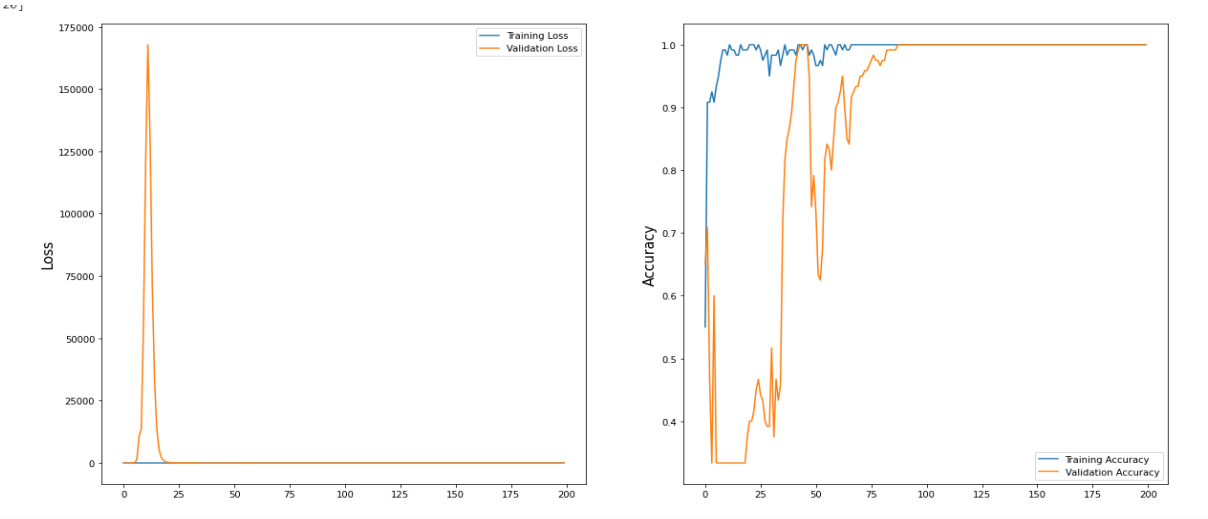

Figure 9: Outputs of Inception resnetV2 feature extraction graph

4.5. Disease Classification and Experimental results:

In this paper, we use convolutional neural networks for classification. After extracting the features from inception resnetV2, VGG19 (Visual Geometric Group 19), and inception V3

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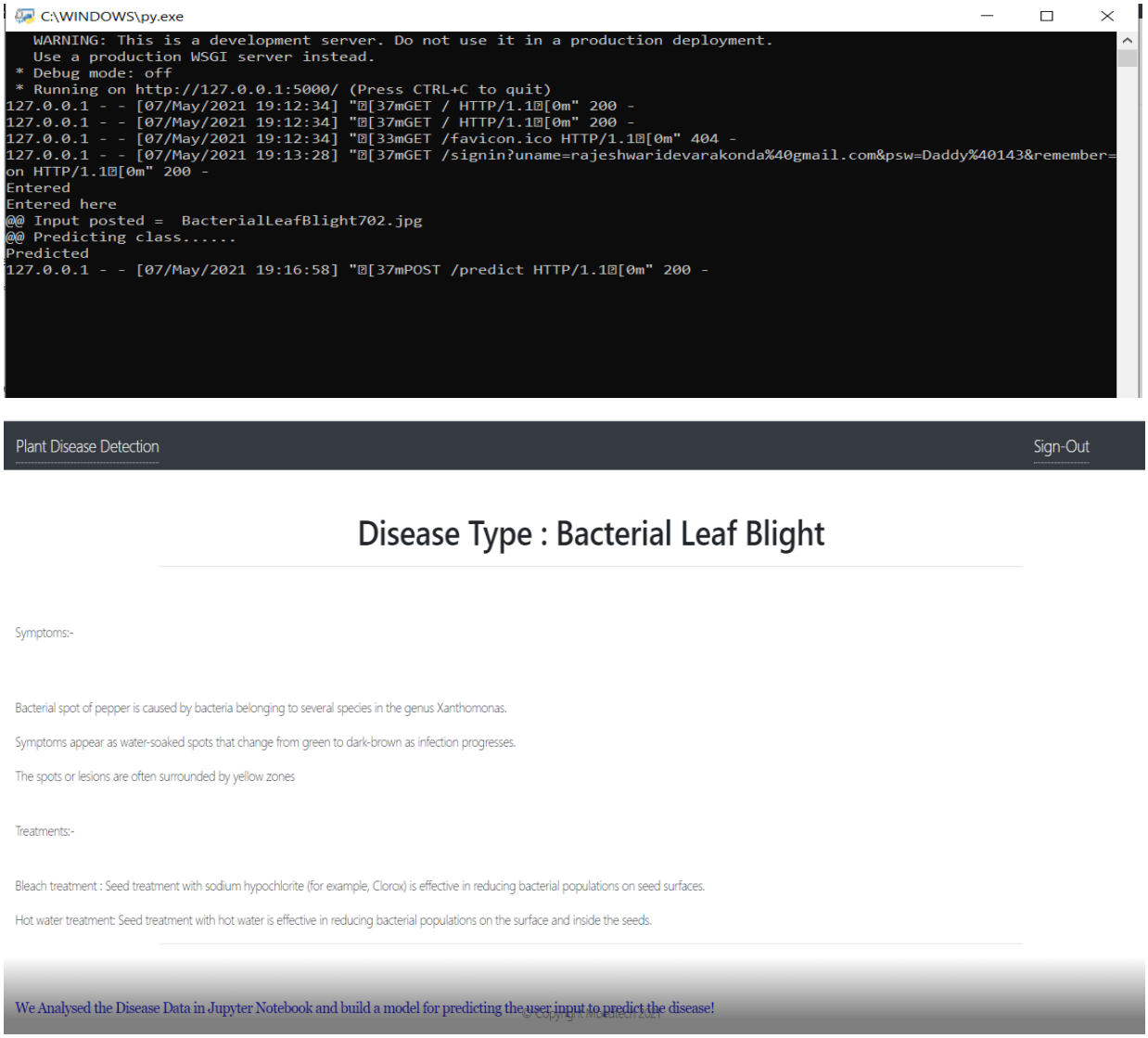
model, CNN (convolutional neural networks) are used to train the design and to detect the plant leaf disease like Brown spot, Bacterial blight and Leaf smut are the leaf diseases which are detected by our application or website. The project has N number of input data and we need to upload the data and we need to predict the required output whether the leaf is healthy or not healthy, if the leaf is not healthy then it output will be any one of the above three fungal diseases of plant leaf diseases. The below figures shows that the leaf which we given as an input data that leaf is unhealthy and it is affected by the fungal disease called Bacterial leaf blight. And we should run this application using a below URL (i.e., URL of the website is http://127.0.0.1:5000/). Above figure shows that in python execution field it shows that the output is retrieved. And the figure shows that complete details about the data which we given as an input, and also it retrieves the symptoms, causes and treatment of that particular fungal disease.



6. Conclusion:

In this paper, we used convolutional neural network model using Inception V3 model, Inception resnetV2, VGG19 (Visual Geometric Group 19) and Adam Optimizer to diagnosis and classify rice plant fungal diseases like bacterial leaf blight, Brown spot and Leaf smut we achieved an accuracy of 90% over the test dataset in classification.A farmer can use our

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platform to develop a server room from which he would effectively track the plants health issues to increase crop yield and identify and diagnose diseases in their initial stages.

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